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THE MINERAL INDUSTRY OF THE BRITISH EMPIRE

AND

FOREIGN COUNTRIES.

WAR PERIOD.

BISMUTH.

(1913-1919.)

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GENERAL.

Bismuth minerals are numerous, but most of them are of uncommon occurrence. Those occurring in ores are chiefly the native metal and the sulphide, bismuthinite. Of the oxidation products of bismuth, bismutite is the commonest. Bismuth minerals contain a high percentage (81 per cent. or more) of bismuth, but the ores as mined seldom contain more than 10 to 20 per cent.

Bismuth ores are commonly connected with intrusions of granite and porphyry, and when of high grade are frequently associated with tin and tungsten ores. In smaller quantities bismuth minerals are associated with lead, zinc, cobalt, copper, gold and silver ores, and the metal is recovered to some extent as a by-product in the metallurgical treatment of these ores.

Bismuth and its compounds have a variety of uses. The metal is valuable as an ingredient of various "fusible alloys." In Rose's metal and Newton's metal it is alloyed with lead and tin. In Wood's metal and Lipowitz' metal it is alloyed with tin cadmium and lead. Bismuth is an ingredient of some antifriction and stereotype metals. Bismuth compounds are used in the manufacture of drugs and medicines and also of certain pigments.

WORLD'S PRODUCTION.

The production of bismuth and the market price of the metal have been strictly controlled for many years, and Messrs. Johnson, Matthey and Co. Ltd., a London firm, are the chief buyers The world's supply is obtained partly from bismuth ore, and partly from bismuth metal obtained during the process of electrolytically refining lead and copper.

Bolivia is the chief producer of bismuth. Other important producing countries are Australia, Mexico, Peru, and Saxony. During the period under review an occasional shipment of bismuth ore has been reported from the "Kjenner Bismuth" mine in Norway, and both Spain and Chile produced small quantities.

During the war there was an increased demand for bismuth both for the manufacture of certain low-temperature fuses and for medicinal purposes. To meet this increased demand there was a larger recovery from the residues resulting from the magnetic separation of tungsten ores, and from the greatly increased production of lead and copper ores.

*World's Production of Bismuth.**

In long tons (2,240 lb.).

	1913.	1914.	1915.	1916.	1917.	1918.	1919.
Australia :—							
(*a*) Bismuth ore and metal	15	31	27	37	29	37	23
(*b*) Bismuth-wolfram concentrates	182	193	247	137	131	114	140
Spain :—							
Ore	55	39	17	11	14	33	74
Bolivia (exports) :—							
(*a*) Bismuth concentrates	415	430	652	439	58	75	
(*b*) Bismuth ore	—	110	—	165	119	110	
(*c*) Bismuth residue ...	—	—	—	53	98	53	
(*d*) Bismuth ingots ...	—	—	—	—	251	245	
Peru :—							
Metal	25	11	—	—	1	—	
Japan :—							
Ore	—	3	7	1	1	1	

* In addition to the countries mentioned in this table, Rhodesia, India, Germany, Norway and the United States have produced bismuth. The total production of ore in Rhodesia to the end of 1918 was 4 tons. In 1917 India produced 5 cwt. of metal. Norway, in 1915 and 1917, produced a total of 20 tons of low-grade ore. Figures for Germany are not available. China is reported to have produced a considerable amount during 1919.

PRICES.

The Bureau is informed by Messrs. Johnson, Matthey & Co., Ltd., that the official prices of bismuth during the period under review have been as follows :—

	per lb. *s.*	*d.*
January, 1912, to August 17, 1914	7	6
August 18, 1914, to March 7, 1916	10	0
March 8, 1916, to January 27, 1918	11	0
January 28, 1918, to January, 1920	12	6

Bismuth ore to be marketable should contain at least 10 per cent. of metallic bismuth by assay. The rate paid for ores depends largely upon the percentage of bismuth; but when objectionable impurities are present the prices are always lower. These impurities include iron, copper, arsenic, lead, and tellurium.

BRITISH EMPIRE.

Very little bismuth ore is produced in the British Empire. The only country within the Empire where bismuth mining operations have been carried out continuously during the period under review is Australia, where bismuth is mined in the States of New South Wales, Queensland, and Tasmania. In the Tavoy district of Burma, bismuth occurs in small amounts in the tin and wolfram concentrates. Rhodesia has produced a small amount.

United Kingdom.

Bismuth minerals occur sparingly in Cornwall in some of the tin and copper lodes, but no bismuth ores have been mined in the United Kingdom during the period under review, and no statistics relating to imports, exports, and consumption are available.

Rhodesia.

All the commoner ores of bismuth have been reported as occurring in Rhodesia, notably at the Hay Mine, Mazoe, where bismuth sulphide occurs associated with molybdenite and iron-pyrites. The mine was formerly worked for gold only, and it does not appear that any efforts were made to save the bismuth.

In many of the gold-bearing veins in the Victoria and Lomagundi districts, considerable quantities of bismutite are associated with the gold, whilst native bismuth and bismuth-ochre have been found in the Hartley and Gadzema districts.

Production during the period has been obtained chiefly during prospecting operations and has never exceeded a few hundredweights of ore annually.

India.

Bismuth ores have not yet been discovered in commercially valuable deposits in any part of India. In the Tavoy district of Burma native bismuth and bismuthinite sometimes occur sparingly in veins containing wolfram, cassiterite, and molybdenite; but during the period under review no output of bismuth of any importance has been recorded from any of the Tavoy mines. Other areas are the Amherst and Mergui districts in Burma, and Bihar and Orissa, where traces of bismuth are associated with the Singhbhum copper deposits. The Tavoy district yielded 5 cwt. of bismuth ore, valued at £163, in the year 1917.

Australia.*

New South Wales.—Bismuth ores are found in New South Wales in pipe-like veins penetrating granite at or near its contact with clay slates.

In the Glen Innes division at Kingsgate there are a large number of these deposits along a strike of about 2 miles. The gangue of the veins is quartz, often containing pockets of molybdenite crystals of large size associated with arsenopyrite and wolfram. The bismuth ores consist of carbonate and oxide at the surface, passing into sulphide and native bismuth at some depth. The bismuth ores frequently carry appreciable quantities of gold and silver. Mining operations are carried out intermittently and on a small scale, the output depending upon the market price of bismuth.

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* Annual Reports of the Department of Mines, New South Wales. Annual Reports of the Under Secretary for Mines, Queensland. Annual Reports of the Department of Mines, Western Australia Annual Reports of the Secretary for Mines, Tasmania.

The chief producing district is Whipstick in the Pambula division, where the deposits are very similar to those at Kingsgate except that the ore carries no wolfram. Other districts in which bismuth occurs are the Deepwater, Tenterfield, Goulburn, and Oberon divisions.

Queensland.—Small quantities of bismuth and wolfram-bismuth ore have been obtained from the mining districts around Wolfram and Bamford, in the Chillagoe field. The ore occurs in pipes and vugs traversing quartz; it consists chiefly of molybdenum and wolfram, often associated with smaller quantities of bismuth. As a rule the bismuth is not separately recovered from the wolfram, but remains in the concentrates, and is classed as wolfram-bismuth concentrates. No details are available regarding the exact composition of these concentrates.

The State battery at Bamford treated profitably many parcels of low-grade ore which could not bear high transport charges, and proved of considerable assistance to many of the small privately owned properties ill-equipped with crushing and concentrating machinery.

Tasmania.—Bismuth ores (bismuthinite, bismutite, and native bismuth) occur at the Federation Mine in the South Heemskirk Tin-fields, associated with tin and wolfram; and more particularly at the Shepherd and Murphy Mine and the Lady Barron Mine in the Middlesex and Mount Claude Mining Field, also associated with wolfram and tin.

During the period under review the production of bismuth in Tasmania has been small and confined to the production of concentrates which were shipped to England for treatment.

Production of Bismuth in Australia.

Year.	New South Wales		Queensland.				Tasmania.		Western Australia.*	
	Ore and metal.		Metal.		Bismuth and wolfram concentrates.		Metal.		Ore.	
	Quantity (long tons).	Value (£).	Quantity (long tons).	Value (£).	Quantity (long tons).	Value (£).	Quantity (long tons).	Value (£).	Quantity (long tons).	Value (£).
1913	8·7	1,202	1·6	618	182	17,867	5·1	1,627	—	—
1914	15	2,837	1	282	193	15,319	5·6	1,666	9	635
1915 ..	18·4	4,981	2·5	772	247	26,003	5·5	1,203	1	37
1916	29·5	5,473	3·5	1,530	137	19,069	3·5	1,059	0·25	133
1917	20·5	9,391	4	1,297	131	21,172	1·2	895	0·5	24
1918	31·2	16,406	1·1	588	114	18 041	4·6	1,038	—	—
1919	19·5	20,215	2		140		1·8	573		

* Exports

FOREIGN COUNTRIES.

Mexico.

High-grade bismuth ore is worked chiefly in the States of Sinaloa and Sonora. The Belen mine in Sonora and the Mariposa mine in Sinaloa are the principal producing centres of high-grade ore. Low-grade ores carrying about 2 per cent. of bismuth are common throughout these States and there are rich oxidized ores near Ojo Caliente in Chihuahua.

United States.*

No deposits of bismuth ore of any importance are mined in the United States. A little bismuth ore has been produced in the Deep Creek mountains of Utah, and in Colorado. The gold placer deposits of Alaska also yield a small supply. Practically all the bismuth produced in the United States is found associated with the ores of gold, silver, copper, and lead, more particularly those mined in the States of Utah, Colorado, and New Mexico. The bismuth does not occur in the ores in sufficient quantity to allow the deposits to be worked for bismuth alone, and the metal is recovered as a by-product during the process of smelting and refining the ores and bullion. It is probable that much of the bismuth contained in the ore passes up the smelter stacks and is lost, but the Cottrell system of fume precipitation is being adopted, and this will yield a considerable addition to the supply of domestic bismuth in the United States, should it prove feasible to separate the bismuth from the resulting dust and fume.

The larger proportion of the domestic supply is obtained during the process of smelting and refining lead ores, notably those from the Tintic mines in Utah, and from Leadville, Colorado, where high-grade bismuth ores occur frequently as irregular deposits in veins of silver-lead ore. Such ore is smelted separately and the bismuth recovered during the subsequent refining of the lead bullion.

Bismuth values ranging from a third of a pound to 27 lb. per 100 tons of blister copper have been recovered during the electrolytic refinement of blister copper from some of the Californian and Nevada smelters.

Before the war a considerable amount of bismuth metal was imported into the United States from the United Kingdom and Germany. During the war these imports declined appreciably, partly owing to war conditions, but chiefly to the great expansion of the domestic lead-mining and smelting industry. The demand for bismuth was met by the increased production of by-product metal from silver-lead ores and bullion partly imported from South America.

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* **Mineral Resources of the United States**; U.S. Geol. Surv. (Annual).

Bismuth imported for consumption into the United States.

Year.	Quantity (long tons).	Value. £
1913	53	44,429
1914	40	34,418
1915	20	22,560
1916	34	40,828
1917	31	29,646
1918	61	57,765
1919	26	11,496

Bolivia.

Bolivia is the leading producer of bismuth. The chief mines are those of the Tasna and Chorolque districts.

At Tasna the ore occurs in numerous veins cutting a slate formation. The most productive veins are situated on the eastern slopes of Tasna mountain. In addition to bismuth minerals, these veins contain argentiferous galena, stibnite, arsenopyrite, pyrite, and quartz. On the western side the bismuth veins contain tin and tungsten minerals.

At Chorolque, where the veins occur in andesite, the bismuth is associated with ore minerals of silver, tin, and tungsten.

Other producing regions lie farther to the north, notably at Huayna-Potosi in the district of La Paz, where the deposits are remarkable for the high percentage of native bismuth contained in the ore. The associated minerals are cassiterite, iron-pyrites and copper-pyrites. As a rule the native bismuth and high-grade concentrates are shipped to Europe and the United States for treatment. The low-grade concentrates carrying less than 10 per cent. bismuth are smelted locally.

*Exports of Bismuth from Bolivia**

(in long tons).

Year.	Bismuth Concentrates.	Bismuth Ore.	Bismuth Residue.	Bismuth Ingots.
1913	415	—	—	—
1914	430†	110	—	—
1915	652	—	—	—
1916	439	165	53	—
1917	58	119	98	251
1918	75	110	53	245
1919				

* Comercio Especial de Bolivia (Annual).
† Metal content 50%. Not stated in other years.

Peru.

In the San Gregorio mine situated in the department of Junin, Peru, there are bismuth deposits of considerable importance. The ore occurs entirely as oxidized bismuth compounds in brecciated sandstone, associated with brown and yellow clay. The deposit extends over a length of 1,000 feet; it has a width of 80 feet, and is worked opencast to a depth of 20 feet. Below this level the bismuth value decreases, and no bismuth sulphides have been found in depth from which the oxidized compounds might have originated. The average grade of the ore is from 2 to 3 per cent. bismuth. The ore is concentrated at the Hauraucaca smelter up to 18 to 20 per cent. bismuth. The whole of the middlings carrying 5 per cent. bismuth have been stored for a number of years past. Mining operations were suspended in the year 1914 and work was restricted to treatment of the enormous quantity of accumulated middlings. Operations at this mine are controlled by the bismuth buyers. The mine is not worked to its fullest capacity and is capable of supplying a greatly increased tonnage.

Japan.*

The Japanese production of bismuth is small and chiefly confined to the recovery of bismuth during the refining of lead bullion. A little ore is mined in Korea but the output has never exceeded a few tons annually. The output and values have been as follows:—

Year.	Ore.		Metal.	
	Quantity (long tons).	Value (£).	Quantity (long tons).	Value (£).
1913	—	—	0·31	227
1914	3·4	512	0·08	142
1915	6·5	1,253	3·44	274
1916	0·8	274	0·29	443
1917	1·3	406	0·43	533
1918	0·9	298	0·72	896
1919				

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* Annual Reports of the Department of Agriculture and Commerce.

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